Some applications of designed surface plasmon in periodically structured metal surface

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In the microwave regime, metal is often treated as PEC, which means that the electromagnetic wave can not penetrate into the metal and the metal-dielectric interface can not support surface waves. However, such a metal surface with the array of holes drilled in can still support surface waves, so-called designed-surface-plasmons (DSP's), which have many important properties in common with the electron plasma [1-2].

By analog between the designed surface plasmons and the surface plasmon in the optical region, we explain that the enhanced transmission through a metallic film with a periodic array of subwavelength holes results from two different resonances: i) localized waveguide resonances where each air hole can be considered as a section of metallic waveguide with both ends open to free space, forming a low-quality-factor resonator, and ii) well-recognized surface plasmon resonances due to the periodicity [3]. It is shown that the "shape-effect" [4] in the enhance transmission through the Au film with subwavelength holes is attributed to the localized waveguide resonance.

We also propose that negative refraction can be achieved through designed surface plasmons waves on a metal surface with an array of drilled holes [5]. Using a rigorous full-vectorial three-dimensional finite-difference time-domain method, we also demonstrate the subwavelength imaging of a point dipole source by a slab of such a structure.

In addition, a perfect electric conduct surface with one-dimensional periodic rectangle holes is proposed as a surface-plasmon-like waveguide, where designed surface plasmon modes with very low group velocity are confined in a subwavelength region.

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